USGS
Rocky Mountain Mapping Center

Fits, Starts, and Headway: The Implementation of Geographic Information Systems Technology and Methods in Beginning and Advanced High School Geography Courses

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Abstract

The incorporation of GIS technology and methods has been an intensive but valuable component to new and pre-existing lessons in the geography program at Boulder High School, Boulder Colorado USA. Enhanced learning in local and international lessons resulted from making more variables available and from increased inquiry. Important ingredients of success included the integration of local and real-time data sets, networking with the USGS, the City and County of Boulder, and applying GIS to lessons that had previously been tested. Other key success elements included the participation and interest of the computer laboratory manager and the tenacity of the content teacher.

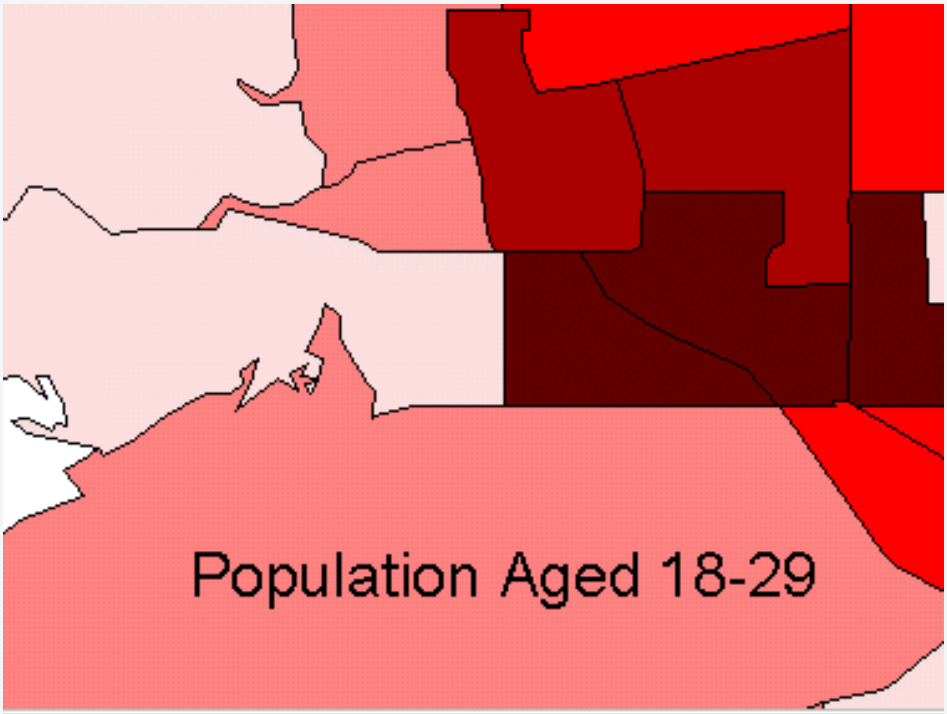
The Hill Project Description

During the 1996 spring semester, Steve Wanner, geography teacher at Boulder High School, and Joseph Kerski, geographer at the USGS, began discussing the possibility of incorporating GIS technology and methods into the geography curriculum at the high school. Contact with the Colorado Geographic Alliance, the University of Colorado, and the city and county of Boulder had familiarized the teacher with the possibilities of GIS in education. The USGS became involved to support users in its many types of digital data that can be used in a GIS. The fact that the teacher was active in the state geographic alliance and that the USGS representative worked in the USGS Rocky Mountain Mapping Center education outreach program made the partnership a natural one. The first meeting took place at a conference of the Colorado Geographic Alliance. This was one of first state-based alliances between primary, secondary, and university geography educators that were established by the National Geographic Society in 1986.

During the summer of 1996, Boulder High School purchased the ArcView K-12 Schools and Libraries package and worked with the Denver Colorado ESRI office. After reviewing the existing lessons in the Grade 11 and 12 World Geography Class, a Boulder neighborhood analysis project was selected as having the best potential for enhanced learning with GIS.

This project was selected because it had been successfully used for several years by the geography teacher, Steve Wanner. A 1972 article in the Journal of Geography identified The Hill neighborhood in Boulder as an urban ghetto (Mason 1972). Lack of spatial mobility, crowded conditions, and low income were among the variables cited as evidence for the claim that the area was a ghetto. This is unexpected reading, particularly in an affluent community such as Boulder, and one that all students from the high school had familiarity. Students were asked to analyze four demographic characteristics and discuss whether the author's claims were true in 1972, and whether they were true today. A narrative report and choropleth maps using colored pencil were two required products from each team of students.

Changes Resulting from GIS



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	Age_18_29	Age_30_49	Age_50_64	Age_65_up
68	467	1630	534	173
59	453	2336	629	196
21	507	1598	433	230
67	792	2382	987	405
42	1045	1161	212	92
27	1243	3025	703	408
34	239	1038	243	74

Introducing GIS did not simply change the number and type of maps that the students prepared--it altered teaching and learning of the entire project. Due to the use of hand-colored maps, the number of variables that could be mapped and analyzed was limited. The problem was solved by introducing GIS into the project. GIS increased the amount and expanded the types of data available to students. Rather than giving the students four variables, over 60 variables were provided, and it was now up to the students to decide which ones supported their position. If a variable did not exist, the students were able to calculate it using ArcView's table calculation function. The paper-and-pencil maps were replaced by ArcView layouts, which allowed for faster map production, permitting time for analysis without extending the project time.

Student and Teacher Reaction

Initially, students were somewhat skeptical of the new technology, even though most of them had previous computer experience. In

order to make them feel more at home with the software, they spent two days working through the ArcView Quick-Start tutorial. This occurred after an introductory lesson on the definition and applications of GIS. They were then asked to select and map 12 to 16 variables to support their position.

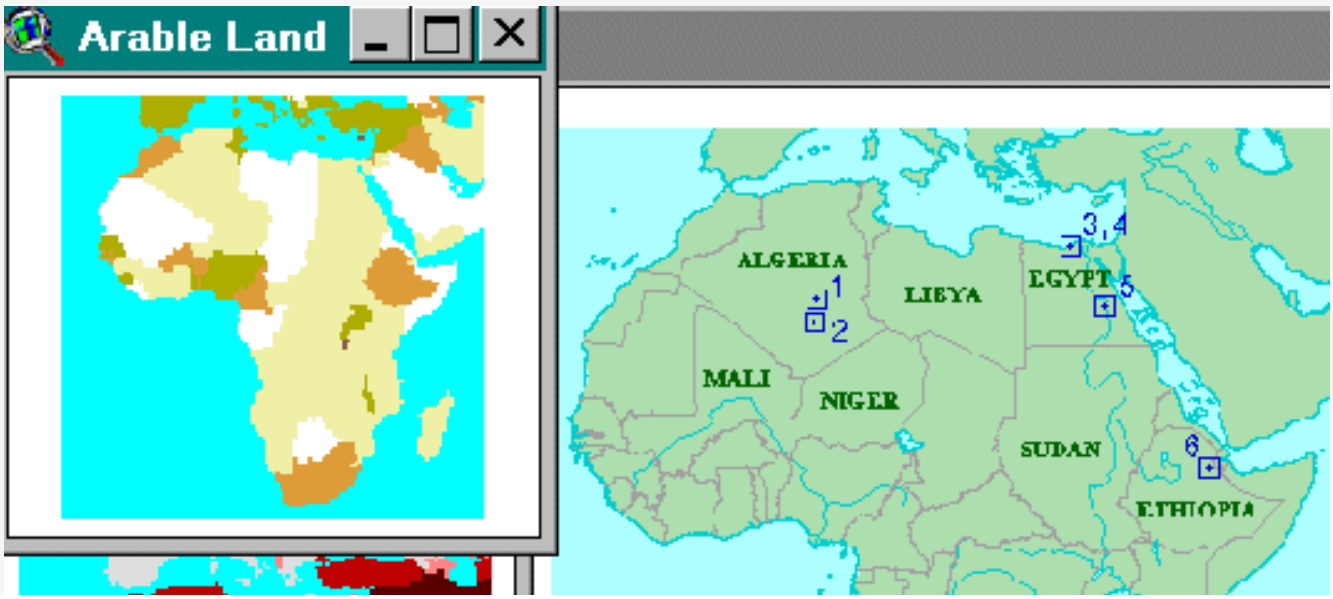
Not only did the students need to grow in their comfort with the software and technology, so did the teacher and computer lab manager. For a teacher with limited computer knowledge, a room full of crashing computers can be quite intimidating! One of the first realizations the project coordinators had was that additional memory was needed to efficiently run the program. Another change that was implemented was that in order to save on printer supplies and time, students were shown how to place more than one map on a layout. This added another software skill.

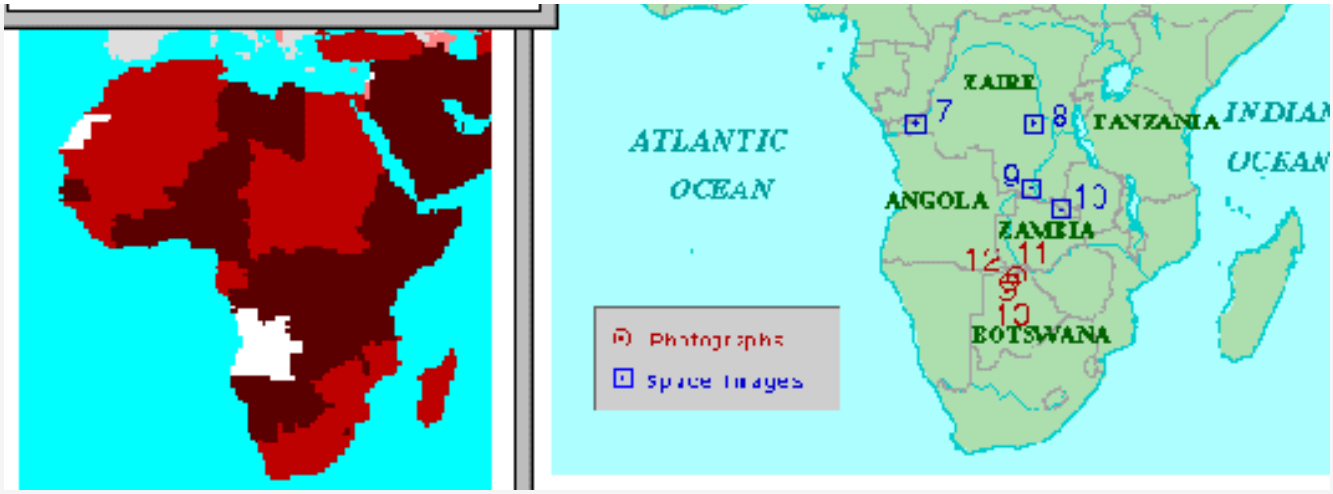
Because students selected their own variables, they had much more ownership of the project with the GIS component added. There was a marked increase in referring to the maps in the essays after GIS was added. Students reacted favorably to GIS. The main concerns were technological--software crashes and printing problems.

Africa Project

During the summer of 1997, the GIS program was expanded to the Grade 9 Introductory Geography classes. In this case, rather than build on an existing lesson, a new lesson on Africa was developed. The new lesson is comprised of four modules. It was selected primarily because a pretest had shown a general lack of knowledge about the continent. Each module requires from one to two days of computer lab time. The first lab occurs about three weeks after a three-day lab session in which students work through the Quick Start tutorial.

ArcView-based modules correspond to units previously covered in class without the technology. Topics included surface





features/ physical characteristics, population/ cultural characteristics, human/natural resources, and natural hazards. The last topic had been used in the class to show how the previous topics fit together in the real world. These topics include elements of both human and physical geography.

Students in each module construct maps from the database provided, and use these to answer a series of questions. While working through the modules, the skills and analysis required become progressively more advanced. In this way, both their skill in using GIS and their thinking are pushed to higher levels.

Keys to Success

Key to the success of the Boulder High School program is the careful, phased approach to implementing GIS into the curriculum. Rather than making massive changes to proven lessons, the implementation has been taking place slowly. If projects had been implemented more quickly, the entire endeavor would have been in jeopardy. The phased inclusion of the projects allowed improvements to be made with time. This also allowed for selection of the points more carefully during the semester when the GIS implementation would be the most effective.

In this way, an assessment of results after each completion of GIS-based lessons was possible. The assessment included an analysis of student essays and maps, and an analysis of the discussion and interaction of students in teams and as a class. A formal experiment will take place during the Fall semester 1998, to provide empirical evidence as to the effectiveness of GIS in student acquisition of geographic knowledge and skills.

Another component in the success of these projects is that they were selected with the goal of sustainability. Sustainable projects will be used many times during the years ahead. They can be modified and improved with time. This was critical in their selection, because of the time-intensive process of making the datasets ready for the student' use and incorporating GIS into the writing of the lessons. The clipping of the vector data and images for the Africa project and loading them on all systems required at least 20 hours. Spending this amount of time on a lesson that would only be used once would not be a wise use of the computer lab managers nor the teacher's time.

Another benefit of sustainability is the addition of a historical component to The Hill project. This will be accomplished by analyzing 1960, 1970, and 1980 census data, and using 2000 census data when available. This will add a new dimension to the project.

Because of the intensive memory and processing requirements of ArcView, and because students using the program would need to use all lab hardware, it became evident early in the GIS implementation that the computer lab manager needed to become fully involved. As in most high schools, the laboratory at Boulder High School is extremely heavily used. Students using GIS could not jeopardize the full use of the computers by students in other classes. Boulder High School was fortunate throughout these projects to have had the support of Naomi Salaman. Because Ms. Salaman taught numerous computer science classes in addition to her duties as lab manager, she understood the needs of teachers, students, and the requirements of the technology. During the first semester for the neighborhood project, ArcView was run on 486 PCS with 8MB of RAM. Despite the frequent system problems inherent with such a configuration, the project was successfully completed. However, students became frustrated with the slow speeds and often did not grasp the overall aims of the lesson. During the following semester, the project was conducted on Pentium-based PCS. The following year, the GIS projects were ported to a Macintosh laboratory, and after some conversion problems, it proved successful in this lab as in the PC lab.

Another benefit to the use of GIS has been increased recognition of the geography program at the school. The school was selected as the site of the 1997 and 1998 Earth and Space Science Technological Education Project (ESSTEP), coordinated by the Geological Society of America. Thirty teachers from primary to university level from across the United States were trained in the school, in science and geography technology. The technology included GIS, remote sensing, Internet, multimedia, and GPS. The GIS projects at the school have also been the subject of presentations and workshops at the ESRI User Conference, Colorado Geographic Alliance, GIS In the Rockies, the National Science Teachers Association , the Arizona Geographic Information Advisory Council, and the National Council for Geographic Education.

Expanding the Projects

The Hill project can be expanded with the use of additional digital spatial data. For example, digital raster graphics of USGS topographic maps, and USGS digital orthophoto quadrangles are planned for the future. Descriptions of these products can be found on the USGS mapping WWW resources.

One area where students are already using their new skills is in the production of maps for other classes using ArcView. For example, one student constructed a map using ArcView for a French class. It will be interesting to observe the Grade 9 students who have used GIS throughout their high school careers.

Plans are being made to show business, history, and science teachers how to integrate GIS into their curricula. The most ambitious plan is to offer a high-school GIS class co-caught by a technology specialist and a geography teacher. This class would emphasize both the technological and geographical aspects of GIS. It would examine real-life, community-based issues, and may be implemented in a few years.

Implementing GIS into the curriculum has required a great deal of work. Yet it has also been a process resulting in a great deal of payoff--skill building, the exploration of new technology, and new

ways of teaching and learning.

References

Mason, Peter F. 1972. Some characteristics of a Youth Ghetto in Boulder, Colorado. Journal of Geography, National Council for Geographic Education. 71(9): 526-540.

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